REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*

2. REPORT DATE

3. REPORT TYPE AND DATES COVERED
Technical Progress Rep. 1/1/96-12/31/9

4. TITLE AND SUBTITLE
Integrated Optic Polarizer/Modulator Status Report

5. FUNDING NUMBERS

6. AUTHOR(S)
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7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
University of Alabama in Huntsville
Huntsville, Alabama 35899

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
U.S. Army Research Office
P.O. Box 12211
Research Triangle Park, NC 27709-2211

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

19970307 085

11. SUPPLEMENTARY NOTES
The views, opinions and/or findings contained in this report are those of the author(s) and should not be construed as an official Department of the Army position, policy, or decision, unless so designated by other documentation.

12a. DISTRIBUTION / AVAILABILITY STATEMENT
Approved for public release; distribution unlimited.

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

This report covers the development of theoretical knowledge and expertise necessary for the authors' 1997 dissertation research involving integrated optic waveguide modulators fashioned from polymers. Included is the 1997 plan/schedule for research into the polarization properties of polymeric waveguides and also the schedule for developing a more efficient modulator. This research supports the development of the Fiber Optic Gyroscope (FOG).

DTIC QUALITY INSPECTED 4

14. SUBJECT TERMS
Waveguide
Polymers
Fiber Optic Gyroscope

15. NUMBER OF PAGES
3 text/diagram

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRAC
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	UL

UAH
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January 8, 1997

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Re: Technical Report - DAAH04-94-0109

Enclosed are ten (10) copies of the technical report for the period of January 1, 1996 to December 31, 1996 as required by the above referenced contract. Additional distribution has been made as shown below.

If you have any questions or need assistance, please contact Donna Fork, Contract Administrator or myself at 205-890-6000.

Sincerely,

Darryell Fortier

Darryell Fortier
Contract Assistant

enc.

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ARO PROPOSAL NUMBER: 95-050

PERIOD COVERED: JAN. 1, 1996 - DEC. 31, 1996

INTEGRATED OPTIC POLARIZER/MODULATOR STATUS REPORT

CONTRACT NUMBER: DAAH04-94-0109

INSTITUTION: THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

AUTHORS: DR. CHI C. SUNG AND ARTHUR C. ELLIS

PERSONNEL SUPPORTED: ARTHUR C. ELLIS

INTEGRATED OPTIC POLARIZER/MODULATOR STATUS REPORT

Dr. Chi C. Sung and Arthur C. Ellis

Dec. 11, 1996

Between Jan., 1996 and the present, I have been conducting research under Dr. Paul Ashley (MICOM) with the purpose of designing a highly efficient integrated optic modulator that is also capable of supporting a single, highly polarized mode of light. This device will be used to bias the output of a fiber optic gyroscope (FOG) being developed by the U. S. Army. Throughout 1996 I have been developing skills involving the fabrication and testing of integrated optic devices and have been concurrently developing a better theoretical understanding of dielectric wave guides. This has led to the construction of a prototype polarizing wave guide via the fabrication technique of photo-lithography.

The proposed modulator will consist of polymeric wave guide channels that modulate light via the application of an electric field across the channels. For the FOG, a Mach-Zehnder interferometer will be fashioned from the polymers, and both arms will be modulated in with attached electrodes. The research and knowledge gleaned will enhance understanding of polarization in polymeric wave guides, and an original design concept, E-field tailoring , will be examined as a modulation scheme to increase efficiency.

Attached is an outline of the planned research schedule for the year of 1997. It can be seen on the timeline at the end that polarization and modulator design processes will be conducted concurrently. If the modulator scheme proves unfeasible, all energy will be devoted to the polarization study.

Note that the steps presented in the outline (Next two pages) have been marked on the timeline (Final page). This schedule will also serve as the course of endeavor leading up to the Ph.D. degree at the University of Alabama in Huntsville for Arthur Ellis.

PLAN AND SCHEDULE FOR DISSERTATION RESEARCH AND WRITING

I. Modulator
   A.. Case Study of options for E-field tailoring using varying resistance and electrode size
      1. TM electrode configuration (Photolithography)
      2. TE electrode configuration (RIE)
      3. TM electrode configuration (RIE)
      4. TE electrode configuration (Photolithography)
   B. (Decision point) Answer questions about options raised in case study
   C. Reduction of options (To determine an optimal design for fabrication and testing using existing model and knowledge of materials and fabrication processes)
      1. Use Shuping's model (Accounts for electrode size, resistivities, dielectric constants, fields, and channel geometry) to examine the four options in A.
      2. Use available knowledge of materials and fabrication techniques to examine the options.
      3. Establish figures of merit for the options in A.
      4. (Decision point) Make a final decision on an option and make final design plans (such as determining a mode size that matches a relevant optical fiber), or decide if the modulator is worth pursuing further at all
      5. If it is determined that the modulator scheme is not feasible, divert all time to polarizer study in II.
   D. Construct best option modulator in a Mach-Zehnder configuration (Option selected in I. C.)
   E. Test and Characterize the device
      1. V_π
      2. Other items that could prove critical
         a. Check throughput
         b. Check mode size
   F. (Decision point)Reconsider design
      1. Is its performance favorably comparable to the figure of merit previously established?
      2. If not, is there time to attempt construction of the next best option selected in C. ?
      3. If there is not time, record knowledge gleaned

Concurrently, the polarizer will be examined:

II. Polarizer
   A. Case study
      1. Mechanisms
         a. Leaky mode scheme
            i. Birefringent cladding
            ii. Birefringent core
         b. Dimensional considerations (Maximization of transverse geometry to support desired polarization)
      2. Material considerations
      3. Fabrication techniques (Photolithography or RIE)
   B. (Decision point) Answer any questions raised by the case study
   C. Reduction of Options (To determine best design(s) for fabrication and testing using existing models and modifying models is necessary)
      1. Establish figures of merit for given mechanism/materials/geometry/manufacturing technique with existing models
         a. BPM (TE planar)
         b. Rprofile (solves fields for TE planar geometry)
         c. TAT (Effective index method)

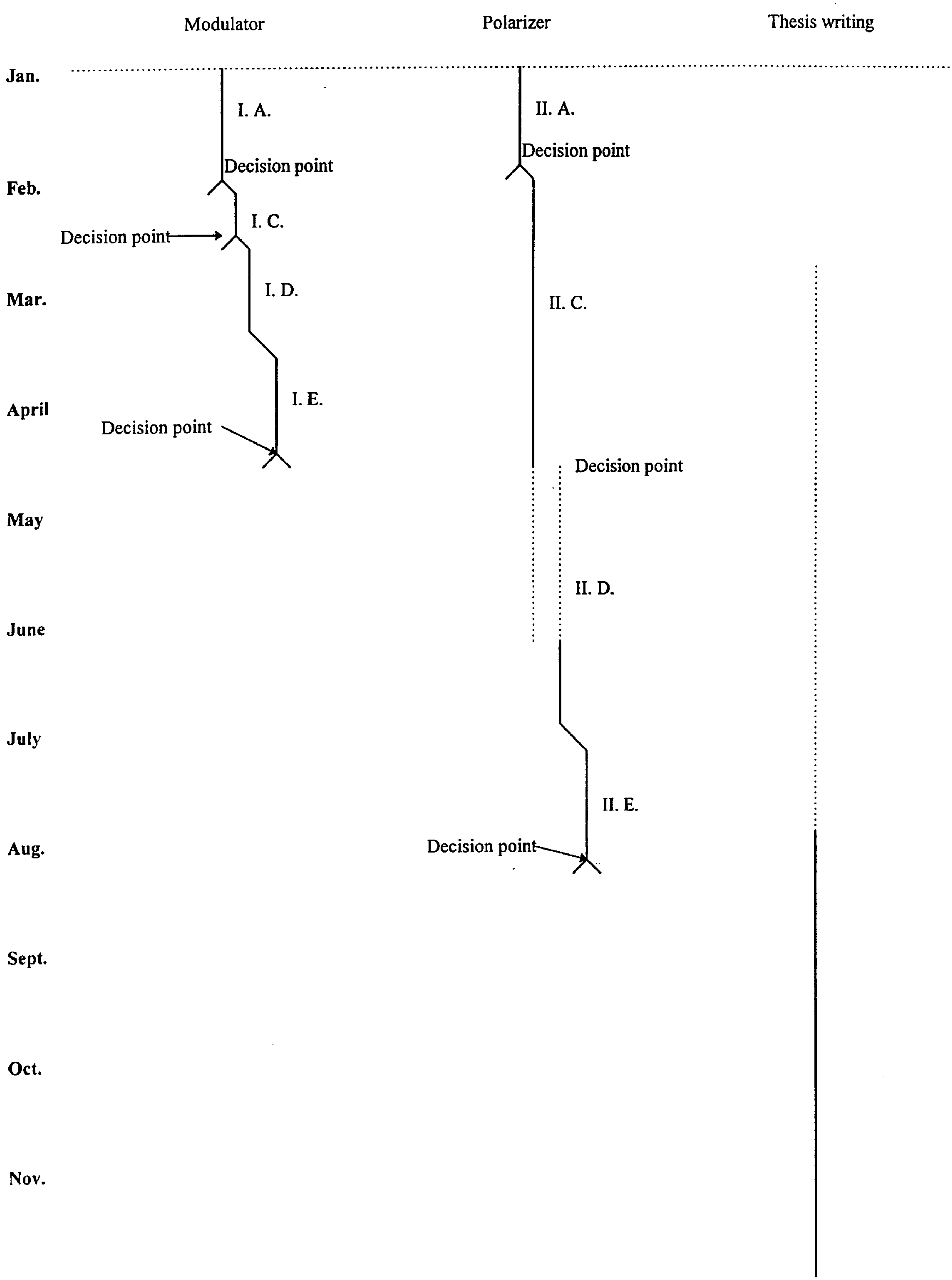
2. Modify existing models if necessary to deal with
    a. Both TE and TM modes
    b. Scattering and 2D channel cross section geometry (if adequate theoretical support is available)
3. (Decision point) Select best design alternative(s)

D. Construct polarizer(s) chosen in II. C.

E. Test/characterize
1. Extinction ratios
2. Cross polarization
3. Modal output profile

F. (Decision point) Compare with models and reconsider design if necessary

SCHEDULE


Modulator
Polarizer
Thesis writing
Jan.
Feb.
Mar.
April
May
June
July
Aug.
Sept.
Oct.
Nov.
I. A.
Decision point
I. C.
Decision point
I. D.
I. E.
Decision point
II. A.
Decision point
II. C.
Decision point
II. D.
II. E.
Decision point